CHEMWHIZ QUICK REFERENCE

TOPIC 14

Chemical Bonding & Lewis Structures

Valence counting, the octet rule, drawing structures, formal charge, exceptions, and resonance.

01 Count valence electrons

CORE RULE

Total = sum of each atom's valence electrons (main-group group number: H 1, B 3, C/Si 4, N/P 5, O/S 6, halogens 7) + 1 per negative charge − 1 per positive charge. The finished structure must use exactly this many.

02 Octet (duet for H)

CORE RULE

Atoms aim for 8 valence electrons (H for 2). A bonding pair counts toward BOTH bonded atoms; a lone pair counts only for its own atom.

03 Pick the central atom

CORE RULE

Central atom = usually the lowest-electronegativity atom. H is always terminal; F almost always terminal; C is central with H/N/O/halogens (CO_2 → C; H_2O → O; SiO_2 → Si).

04 Bonds & multiple bonds

CORE RULE

Single = 1 shared pair, double = 2, triple = 3. If the central atom is short of an octet, convert a terminal lone pair into a shared pair. A double/triple bond is still ONE bond domain per atom.

05 Distribute the electrons

METHOD

(1) Complete terminal octets first (terminal halogen/O gets 3 lone pairs). (2) Put leftovers on the central atom. (3) If a period-2 central atom is still short, make a multiple bond; period-3+ may keep the extra as a lone pair.

06 Verify the count

CORE RULE

Add it back: 2 e^- per single bond, 4 per double, 6 per triple, 2 per lone pair, 1 per radical. The sum must equal the valence total you started with.

07 Incomplete octets

WATCH OUT

Be and B can be stable with fewer than 8: Be has 4 in $BeCl_2$, B has 6 in BF_3: not enough electrons, and no terminal lone pair worth converting.

08 Odd-electron radicals

WATCH OUT

An odd valence total (NO 11, NO_2 17, ClO_2 19) cannot fully pair, so one atom carries a lone unpaired electron, on the central/less-electronegative atom. That atom is one short of an octet, and that is correct.

09 Expanded octets (hypervalent)

CORE RULE

Period-3+ central atoms (P, S, Cl, Br, I, Xe) can be drawn past an octet: PCl_5 (10), SF_6 (12), also BrF_5, XeF_4. Period-2 atoms (B, C, N, O, F) never exceed 8. Modern models credit delocalized / 3-centre-4-electron bonding, not d-orbital expansion.

10 Formal charge

CORE RULE

FC = valence electrons − nonbonding electrons − (bonding electrons / 2). Equivalently: valence − lone-pair electrons − number of bonds. Sum of all FCs = the species charge (0 for a neutral molecule).

11 Best structure by formal charge

CORE RULE

Prefer: fewest nonzero formal charges; then smallest magnitudes; then negative FC on the more electronegative atom; avoid like charges on adjacent atoms. It is a guideline; defer to species-specific convention when both forms are valid.

12 Resonance

CORE RULE

Resonance forms share atom positions and electron count, differing only in π-bond / lone-pair placement (σ bonds never break). Move a π bond to a lone pair on one side while promoting a lone pair to a π bond on the other; link with ↔.